VAPORIZER - Synthesizer Plug-in User's Manual

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http://www.vast-dynamics.de

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1. Introduction

1.1 Disclaimer

This document describes features of the newest version that was available when the document version was released. It might be required to upgrade to a newer version to use all described features.

There is no guarantee or warranty that the features described here are fully functional in the version that you are using and we are not liable for that.

This manual assumes that you know the basics of subtractive synthesis. If you have any queries or would like to join a lively discussion about Vaporizer feel free to post a message in our forum: http://www.vast-dynamics.de/?q=forum.

1.2 Installation

This software can be downloaded on our web site by using the following link: http://www.vast-dynamics.de/?q=products. All older released versions can be downloaded here: http://www.vast-dynamics.de/?q=downloads.

The installation should be guided and straight-forward. You basically have to follow the steps described in the installation program.

1.1.1 Installation on PC

After you have downloaded the installation archive (.zip) from the website, open the archive (on Windows a free archive program e.g. WinRAR is required) and run the executable installation file (.exe). Follow the instructions in the installation process. You will have to choose an installation folder. This is typically <drive letter:>\Program Files (x86)\Steinberg\VSTPlugins for the 32-bit version and \Program Files\Steinberg\VSTPlugins for the 64-bit version. The installation program will create a subfolder VASTvaporizer that stores all installed files. The installation program copies the VST3 version to the standard VST3 folder on Windows (either \Program Files (x86)\Common File\VST3 or \Program Files\Common File\VST3 depending on 32-bit / 64-bit).

After a successful installation it might be required to add the corresponding plug-in search path to your digital audio workbench (DAW – your host software). Please refer to your DAWs manual to find out how to do that.

1.1.2 Installation on Mac

After you have downloaded the installation archive (.zip) from the website, open the archive and run the DMG file. This will open up a folder in Finder that shows all installable plug-ins and symbolic links for standard paths for the installation. Just drag and drop the plug-in files that you want to install (.component for AU, .vst for VST and .vst3 for VST3 – all three available as 32-bit and 64-bit versions) to the symbolic link folder. This will copy the corresponding file to the destination location.

After a successful installation it might be required to add the corresponding plug-in search path to your DAW. Please refer to your DAWs manual to find out how to do that.

1.1.3 Installation Folder

The folder in which the plug-in file is located is of special importance for Vaporizer. The plug-in expects potential key files and / or setting files in the same folder. This also means that in case that you use different types of the Vaporizer plug-in (e.g. VST 32 bit and VST3 64 bit) different folders will be used. This also means that the key file has to be copied and that different settings will exist.

1.1.4 Key File for Registration

To unlock the full version you need a personalized key file that can be purchased here: http://www.vast-dynamics.de/?q=products. After purchasing you will receive the key file via e-mail – usually within only a few minutes.

In case that you have obtained a key file for the plug-in, you need to store the key file in the same folder that also contains the plug-in file (.vst, .vst3 or component). Please upload it manually to the corresponding location(s). You can verify that the key file is working correctly and unlocks the full version when your license information is displayed in the top-right corner of the user-interface.

Without a key file the plug-in will operate in demo mode. The demo version will mute audio out after ten minutes of testing and does not allow saving of patches / exporting to the host program.

The plug-in does not read any Windows registry entries. It simply expects the key file in the plug-in folder that contains the plug-in file as well.

1.2 System Requirements

The following system requirements are the minimum requirements to run the software:

- Any CPU that supports SSE (Intel Pentium and above, AMD XP and above)[1].
- 128MB RAM or more.
- Microsoft[2] Windows 2000 / XP / VISTA / 7 / 8 (32 / 64 bit) or Mac OS X 10.6 or above.
- A VST / AU compatible host software (32 bit or 64 bit).

Please try the demo version (same download - full version is unlocked with a key file) first to verify that the plug-in is compatible with your system configuration.

It is important to choose a suitable audio buffer size. It is recommended to use a buffer between 128 and 512 samples (at 44.1 / 48 kHz sample rate) as this balances latency and CPU performance. A smaller buffer might lead to an unstable sound output.

2. Overview

Vaporizer is our first VST / AU synthesizer. The intention of this development is to combine a fat virtual analog sound with low system CPU resource usage and a low price.

Even though this synth basically follows a traditional subtractive analog synthesis model, we believe that is has its own character and sound that needs to be explored. A main focus was laid on modelling fat supersaw-like sounds with various unison and detunes models.

Vaporizer does not want to be smooth and gentle. It has sharp edges and can also be brutal.

The intention of Vaporizer is to follow a virtual analog synthesis model that allows an almost unlimited number of oscillators per voice (e.g. 96 saw-tooth oscillators …). The philosophy here is that highest sound quality can only be achieved with the highest possible quality of the underlying waveforms. Therefore Vaporizer does not use samples or wavetables. It generates and calculates all waveforms in real-time. This can only work when oscillators are completely alias free – and the alias-free oscillators are the proud heart of Vaporizer. Modern n-fold PolyBLEP techniques are used to guarantee that especially high frequencies are not distorted with aliasing frequencies as it is often the case with other software synthesizers. With a maximum of 97 parallel oscillators per voice (four unison / detune banks

[1] Intel and AMD are registered trademarks.
[2] Microsoft is a registered trademark.

with max 24 plus one additional noise oscillator) and up to 16 voice polyphony, Vaporizer can calculate a maximum of 1552 oscillators per plug-in at a time.

The signal path was laid out in full stereo for all generators, effects and chains. Vaporizer offers three polyphony modes with 16 and four-voice polyphony plus a monophonic mode.

While many software synthesizers can only produce dry sounds, Vaporizer includes a full effect bank with high quality oversampling effects (distortion, chorus, delay, reverb, comb filter and parametric EQ).

Vaporizer comes with a high and continually growing number of high-quality factory presets with many different styles.

Vaporizer includes many functions that round it off as a complete working horse, e.g. monophonic and polyphonic portamento in all modes including ARP, polyphonic after touch, patch randomization function, a dual LFO with cross modulation. Almost all parameters of Vaporizer can be controlled via MIDI. The heart of all modulation in Vaporizer is the modulation matrix that allows controlling and modulating the sound in almost unlimited ways.

The user interface of Vaporizer is kind of old school and is intended to give a real “analog feeling”. The design principle is to have everything at sight and don’t hide parameters behinds tabs or menus. It includes an eye-catching retro-style oscilloscope for immediate visual feedback of the played sounds.

The following diagram shows the main areas of the Vaporizer user interface.

The UI is divided in the following areas:

- Master Section
- Oscillator Section
- VCA Envelope
- Filter Section
- LFO Section
- Equalizer Section
- Preset Browser
- Effects Section
- Oscilloscope
- Modulation Matrix

- Modulation Envelopes
- Arpeggiator Section
- Keyboard Section

You can find a functional description of all these sections in chapter 4 Functional Description.

2.1 Controlling parameters

All knobs, faders, drop down boxes and numerical fields are controlled by left-clicking on them and dragging the mouse in a vertical direction.

You can also use the mouse wheel for changing the parameters. Just position the mouse pointer over a control without clicking and use the mouse wheel for increasing or decreasing the parameter value.

For better control when fine-tuning the values you can hold CTRL (Windows) or CMD (Mac OS X) while dragging. This will turn the control into "velocity mode" so that the updated range depends on the speed the mouse is dragged, e.g. slight movements will lead to small changes.

Another option for fine-tuning is to click on the numerical value of the parameter directly. This will open up a text editor that allows entering a floating point value directly (see figure above).

2.2 Working with Presets

2.2.1 Changing Programs

There are several ways to change the active preset.

- By using the host software functionality to change programs.
- By using a MIDI program change message (will work for the first 128 presets in Vaporizer only as this is the maximum addressable number in the MIDI standard).

- By using the preset select buttons on the right of the preset display (you can also use the mouse wheel or cursor up / down keys when the preset box is selected, page up / down keys will work as well even when the control is not selected).
- By clicking on the preset name on the preset combo box, this will pop up a **preset browser** that allows navigating to factory and user presets.

2.2.2 Preset Browser

Vaporizer offers a powerful preset browser that allows to easily navigate through all the presets that are available – factory presets that are stored within the plug-in and user presets (created on your own or purchased libraries) that are stored on the files system as .vvp files (VAST Dynamics Vaporizer presets). Note that user presets are only loaded from the file system in the licensed version and not in the demo version of Vaporizer.

The preset browser shows the preset name and meta-data like:

- ID: the user / factory preset number. Factory presets are organized in banks of 28 presets. Banks are listed with capital letters starting with A, B … User custom presets are shown with USR + sequence number. The sequence number is just given by the sequence in the file system and not stable.
- Category: a freely definable preset category, e.g. instrument type ...
- Author: the author / copyright holder of the preset.
- Tag: a freely definable tag for selection and filtering.
- Folder: either “Factory” or the file system folder (top level) that holds the preset file (this can be used to easily structure user presets by just organizing them as desired in file system folders).

Search filter
ID
Category
Author
Tag
Folder
Name
A01 ... VAST Dynamics Factory Factory Factory Preset
A02 Pad VAST Dynamics Factory Factory PAD SuperSaw
A03 Sequence VAST Dynamics Factory Factory SEQ 303Acid
A04 Sequence VAST Dynamics Factory Factory SEQ Tranceponder
A05 Sequence VAST Dynamics Factory Factory SEQ Minor Chords
A06 Hoover VAST Dynamics Factory Factory HOV Detune Hoover
A07 Keyboard VAST Dynamics Factory Factory KEY Analog E-Piano
A08 Pad VAST Dynamics Factory Factory PAD SuperSaw Noise Panned
A09 Synth VAST Dynamics Factory Factory SYN House Pluck
A10 Arpeggiator VAST Dynamics Factory Factory ARP Cosmic Mono
A11 Synth VAST Dynamics Factory Factory SYN EDM Saw
A12 Pad VAST Dynamics Factory Factory PAD Bubble Strings
A13 Synth VAST Dynamics Factory Factory SYN Evil
A14 Hoover VAST Dynamics Factory Factory HOV HooverOne

All the meta-data can be used to filter the result list. You just need to enter the filter value in the text box on the top and only those presets are shown that match the filter. The filter will scan all meta-data values case insensitive.

Clicking on the table headers will sort the (filtered) list ascending or descending.

When single clicking on a preset (or using arrow keys / page up, down) to navigate through the list the preset will be loaded and can be played via the MIDI controller. This allows pre-listening the preset before choosing it.

You can close the dialog with the escape key (if not suppressed by your DAW), by double-clicking on the selected preset or by clicking outside of the pop up.

You can use the settings dialog on the main window of Vaporizer (top-right corner – click on the gear icon) to define the root folder that is used to search for custom presets. All subfolders below this root folder (and the root folder itself) are searched for Vaporizer presets (.vvp files). Important: please make sure that the folder you choose here does not have too many subfolders (like e.g. the C:\ folder) since this will result in long scan times. Typically you will use a subfolder of your VASTvaporizer plug-in folder or a separate folder where you store your presets for other plug-ins as well.

The root folder is stored in the VASTvaporizerSettings.xml file that is created in the Vaporizer folder (see chapter Installation). In case that you need to save this information make sure to copy this file as well.

2.2.3 Saving User Presets

Most DAWs allow saving presets as .fxp files (Steinberg[3] FX Preset File). When creating and saving a project in you DAW, the currently selected preset is saved together with the plug-in state so that it is fully restored after reloading the project.

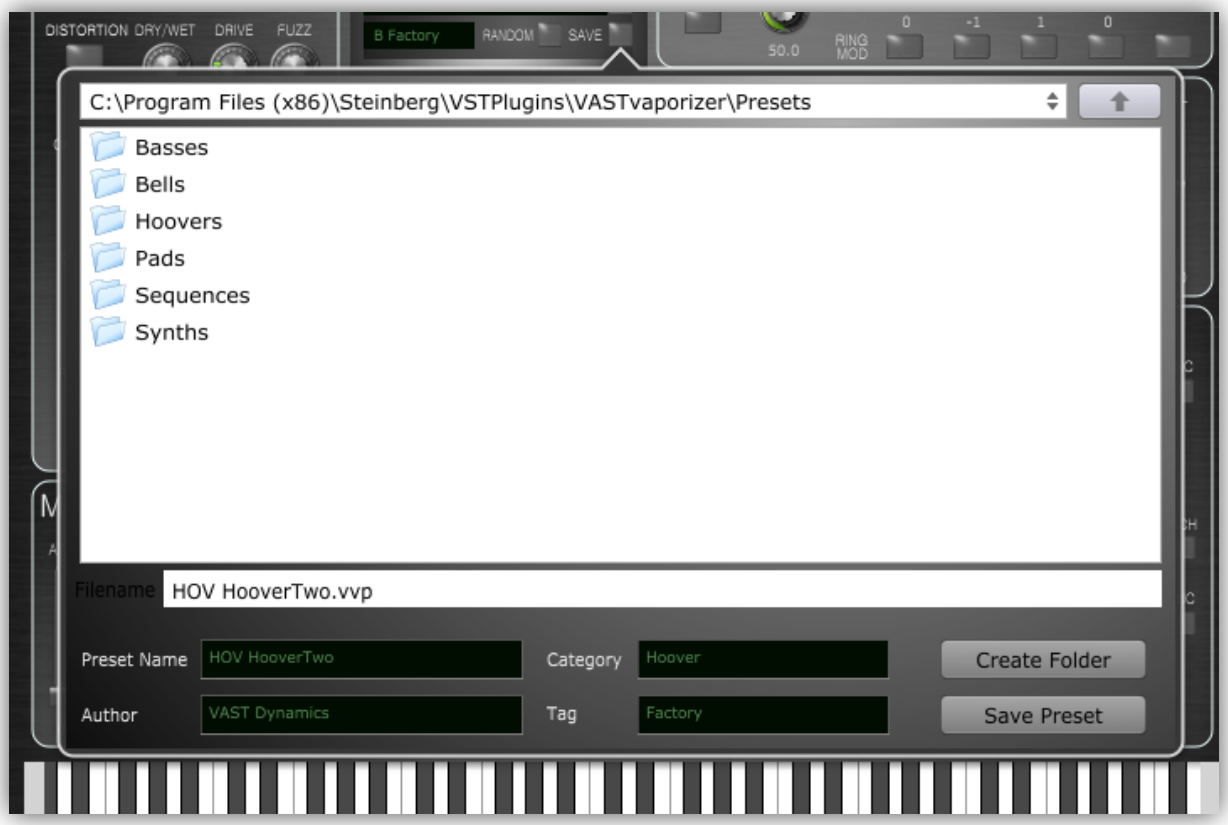
To better support preset management and organization Vaporizer allows to save presets directly from within the plug-in. You just need to use the save button in the preset browser section.

The save button opens a save dialog that allows to save the preset to an arbitrarily selectable file system folder as a proprietary .vvp file. The meta-data that will be used to

[3] Steinberg is a registered trademark.

structure the presets can be directly entered here on the window. You also create subfolders directly from this dialog.

Some DAWs (like Reaper[4]) suppress the space key as it is bound to the DAW transport. A workaround for this issue is to use shift-space when typing text, e.g. the preset name.



After saving the preset the newly created custom preset is loaded and shown with a USR preset number – the preset browser will show the new preset as well the next time it is opened. **It is important to note that the newly saved preset will only be found by Vaporizer if it is saved to the search folder or one of its subfolders that is selected in the Vaporizer settings (see chapter 2.2.2 above).**

Note that saving is disabled in the demo version of Vaporizer.

2.3 MIDI Learn

Vaporizer comes with a default mapping of some of its parameters to MIDI control change (CC) messages (see chapter MIDI Mapping). So by assigning the corresponding CCs to your

[4] Reaper is a registered trademark.

MIDI controller (keyboard) or your DAW you will already be able to control these parameters remotely.

But there are more controllable parameters in Vaporizer as free MIDI CCs. Therefore the MIDI Learn function allows to freely define a custom specific mapping of CCs. This mapping will be persisted and is not preset specific. So it will be available again and again after restarting Vaporizer.

MIDI Learn is accessible by right-clicking on any of the control elements in Vaporizer (knobs, sliders, buttons …). A context menu will pop up and show the following information: parameter name, internal parameter name, parameter description and the currently active parameter mapping. See the following figure:

The following options are accessible from here:

- Learn MIDI.
  Start the MIDI Learn process.
- Forget MIDI mapping.
  Un-assigns the currently used MIDI CC from this parameter.
- Reset all MIDI mappings to defaults.
  This will reset all parameter mappings to the default values (see chapter MIDI Mapping) and persist the default mapping in the settings file.
- Reset all MIDI mappings to not-mapped.
  This will reset all parameter mappings to “not assigned” and persists this information in the settings file.

The MIDI Learn process is as follows: When choosing the menu entry from the context menu the corresponding UI control will be highlighted in red color. See the figure below:

This is the sign that Vaporizer will use the next received MIDI control change information as mapping for this parameter. So all you need to do is to move the knob on your hardware controller that you want to assign. The red highlight will disappear to indicate a successful mapping process.

MIDI Learn is stored in the VASTvaporizerSettings.xml file that is created in the Vaporizer folder (see chapter Installation). In case that you need to save this information make sure to copy this file as well.

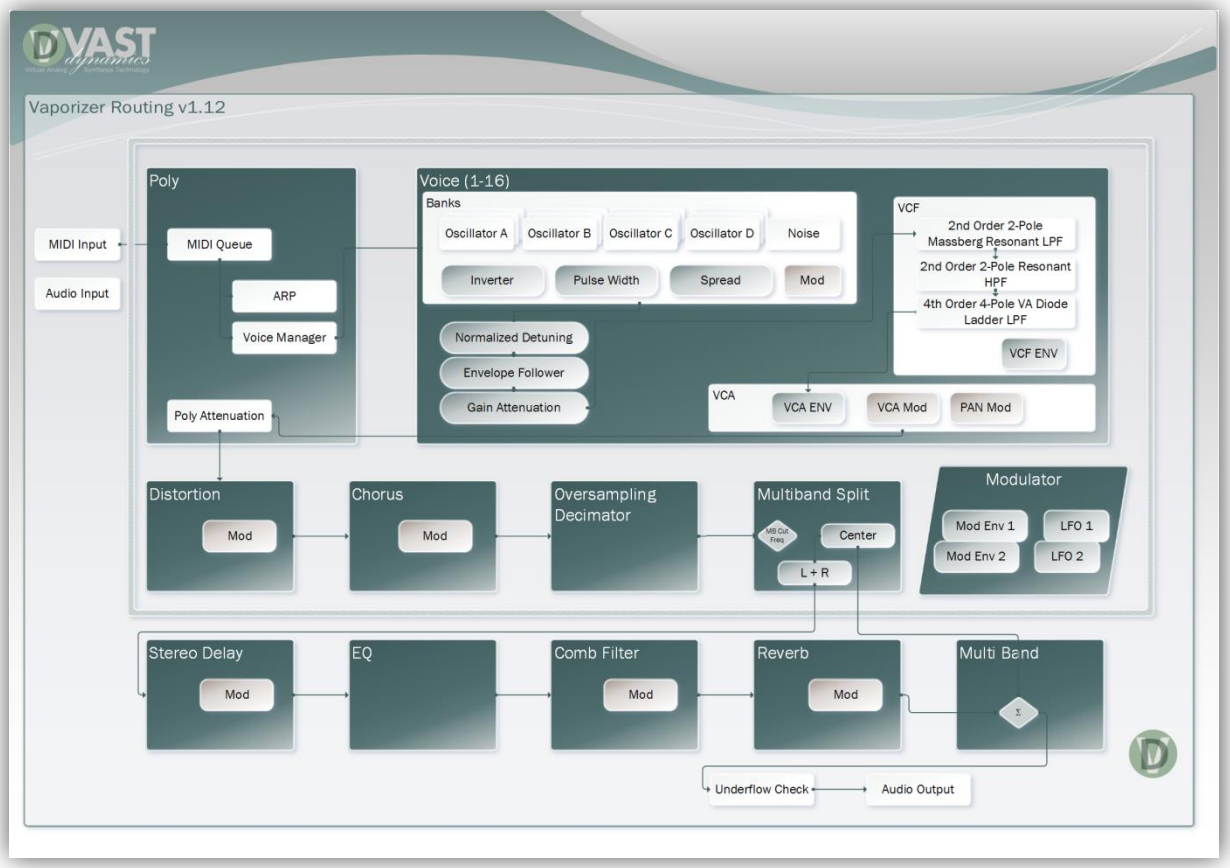
Note that some DAWs like FL Studio[5] require additional settings to pass MIDI control changes to the plugin. Please refer to your DAWs manual for details on this process.

3. Synthesizer Layout and Audio Path Routing

As described above Vaporizer follows a subtractive synthesis model. Yet one of its philosophies is to produce wet sounds that are immediately usable in music productions. Therefore it includes a complete effect bank in the layout.

The following diagram gives a high-level overview about the internal modules in Vaporizer and its routing – note that the complete signal path is laid out to support full stereo:

[5] FL Studio is a registered trademark.



The poly module controls polyphony and the arpeggiator. It manages all available voices and takes care of amplification and attenuation of poly output.

The voice module controls all oscillators with their vast capabilities (normalized detuning, dynamic attenuation …), the filters and envelope generators.

Raw filtered signals can be routed in numerous different ways back to the poly module and from here to the effects section.

The first effects in the chain are distortion and chorus as these effects are part of the oversampled path. This means that when desired and switched on, poly, voices, filters, distortion and chorus can be oversampled by factor four (see chapter Oversampling for details).

A unique capability of Vaporizer is to split the signal in a center and a left and right chain before it is routed in the delay and reverb modules. This feature is called multiband processing and is useful to ensure that stereo and delay effects of low frequencies do not dilute the sound output.

The next effect chain modules are stereo EQ, stereo delay, stereo comb filter and stereo reverb.

4. Function Description

4.1 The Master Section

The master section controls the master volume and the master tune. Both parameters are stored with the preset data as well to allow to fine tune the preset.

4.1.1 Adjusting Polyphony & Portamento

Vaporizer offers three different modes: a monophonic mode, a polyphonic mode with four voices and a polyphonic mode with 16 voices. In all modes a new MIDI note that exceeds the number of voices will lead to releasing the oldest voice that is sustained.

The polyphony mode has an impact on the arpeggiator and the portamento settings as well. In mono mode the arpeggiator will not allow polyphonic modes of course. Portamento will be monophonic in mono mode and glide frequencies between two subsequent MIDI notes. In polyphonic mode the portamento will also be polyphonic and glide all played notes simultaneously.

4.1.2 Pitch Bend and Modulation Wheel

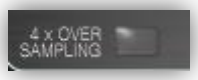
The standard MIDI behavior is that the modulation wheel responds to MIDI CC 1. Vaporizer maps MIDI CC 1 per default to the modulation matrix input source ModWheel (see chapter Modulation Matrix). You can use the modulation matrix to freely assign the modulation wheel to control any of the parameters controllable with the modulation matrix. You can use the MIDI Learn function (see chapter MIDI Learn) to assign MIDI CC 1 to a different Vaporizer parameter directly as well.

Note that some DAWs like FL Studio[6] require additional settings to pass MIDI control changes to the plugin. Please refer to your DAWs manual for details on this process.

[6] FL Studio is a registered trademark.

4.1.3 Oversampling

Vaporizer offers a four-fold oversampling option that can be switched on and off on demand. The oversampling routine is written purely in assembler code and makes high usage of the CPUs SSE instructions. The signal path that is oversampled when switched on ranges from oscillators & filters to distortion and chorus effects. Delay and EQ are not oversampled and the (plate) reverb uses a build in four-fold filter oversampling that is not switchable.



The oscillator section of Vaporizer is designed to be alias free. This is achieved by using state of the art PolyBLEP algorithms to avoid aliasing of standard waveforms. While there is no need for oversampling these oscillators it still makes an audible difference in the higher sound spectrum. For effects like distortion oversampling might be required. Please note that a four-times oversampling is a CPU intensive process. By using highly-optimized assembler SSE routines Vaporizer guarantees that the CPU consumption is not four-times as high compared to a non-oversampled signal. Yet oversampling will have an impact on the CPU consumption for sure.

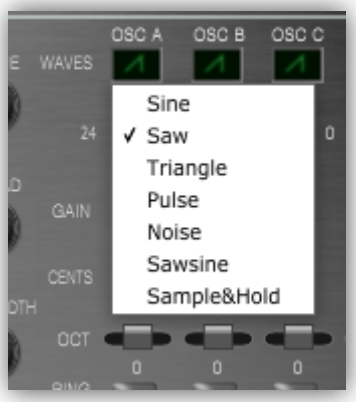
4.2 The Oscillator (OSC) Section

The intention of Vaporizer is to follow a virtual analog synthesis model that allows an almost unlimited number of oscillators per voice (e.g. 96 saw-tooth oscillators …). The philosophy here is that highest sound quality can only be achieved with the highest possible quality of the underlying waveforms. Therefore Vaporizer does not use samples or wavetables. It generates and calculates all waveforms in real-time. This can only work when oscillators are completely alias free – and the alias-free oscillators are the proud heart of Vaporizer. Modern n-fold PolyBLEP techniques are used to guarantee that especially high frequencies are not distorted with aliasing frequencies caused by non-linearities as it is often the case with other software synthesizers. With a maximum of 97 parallel oscillators per voice (four unison / detune banks with max 24 plus one additional noise oscillator) and up to 16 voice polyphony, Vaporizer can calculate a maximum of 1552 oscillators per plug-in at a time.

To achieve this Vaporizer does not limit the oscillators to a small number (e.g. four …). It organizes the high number of completely separate oscillators in banks (bank A, B, C and D and a noise oscillator bank). The oscillators grouped together in a bank are on the one hand

side completely individual oscillators, yet on the other hand side they are managed together for (normalized) detuning and (dynamic) amplification and attenuation.

Vaporizer supports seven different waveform types that are ad-hoc generated: sine, saw, triangle, pulse / square, noise (white noise), sawsine and sample & hold. Sawsine is a special waveform that consists of a half phase of a sine wave and a half phase of a saw wave. This results in a softer type of saw sound. The waveforms of the oscillator banks can be selected by clicking on the waveform symbol.



For each of the oscillator banks you can control the overall gain, the fixed detune (in cents: note that 100 cents correspond to a semitone, so that you can detune here from minus one to plus one octave). For convenience you can also directly control the octave – from minus two octaves to plus two octaves.

A special setting for an oscillator bank is ring modulation. Switching ring modulation on for a bank means that the bank output is not added to the overall signal – instead it is **multiplied**. This allows very special effects. Yet this also means that ring modulation will only produce an

output when at least two banks are active. Note that ring modulation can, by its potentially non-linear design, generate an aliasing output. You can prevent this by using oversampling together with ring modulation.

The invert knob will lead to an inverted waveform output of every second oscillator within a bank. Note that two identical waveforms will annihilate themselves when one is inverted. Therefore wave inversion should be combined with detuning or phase shifting (random retriggering).

The pulse width defines the length of the pulse waveform shape for all pulse oscillators used in banks A-D. It can be controlled from 5% to 95% as 0% and 100% would be a flat wave.

4.2.1 Normalized Detuning

The detune unison algorithm is the heart of the oscillator section of Vaporizer. Simply adding multiple identically calculated waveforms does not give the desired sound effect. In fact it only makes the signal louder. In order to create fat unison sounds out of multiple oscillation sources we need two mechanisms:

- Altering the phase shift of oscillators
- Detuning of oscillator frequencies

With the random retrigger button switched on it is enforced that for each new MIDI note all oscillators within a bank will start the waveform at a random phase position. This will already make multiple stacked oscillators audible. It also makes the generated sound a bit softer in its character and not so sharp in its attack phase. Switching it off will create sounds

with a sharp attack that are suitable for example for basses and stabs as all oscillators will start at the beginning of the phase when a new MIDI note is played.

For detuning the oscillators within a bank there are basically two options:

- Exciter
- Normalized detune

The exciter randomly detunes the oscillators when a MIDI note is played. This gives a slightly hovering sound effect. Since all oscillators have slightly different frequencies, they will run more and more out of phase which adds ambience to the sound.

Normalized detuning is the most complex detuning and de-phasing algorithm in Vaporizer. It is based on detuning all oscillators while preventing that their phases multiply which would lead to unwanted phasing effects. Therefore a frequency distribution is calculated for each value of the detune knob that prevents phase recurrency. Normalized detuning is activate by choosing a “DETUNE” value other than zero (and having an oscillator bank with more than one active oscillator of course).

4.2.2 Dynamic Amplification & Attenuation

Due to the different phases of detuned oscillators the overall gain of the output signal will depend on the exact phase position. With all oscillators operating on the same frequency and phase, the signal will be very “loud” since peaks are multiplied. A random phase will lead to a softer signal. To make sure that this effect is reduced and the bank output always has a homogeneous loudness Vaporizer uses a dynamic amplification and attenuation model for the oscillator banks that is based on an envelope follower. This is done before the gain knobs of the oscillator banks can be used to amplify or attenuate the signal manually.

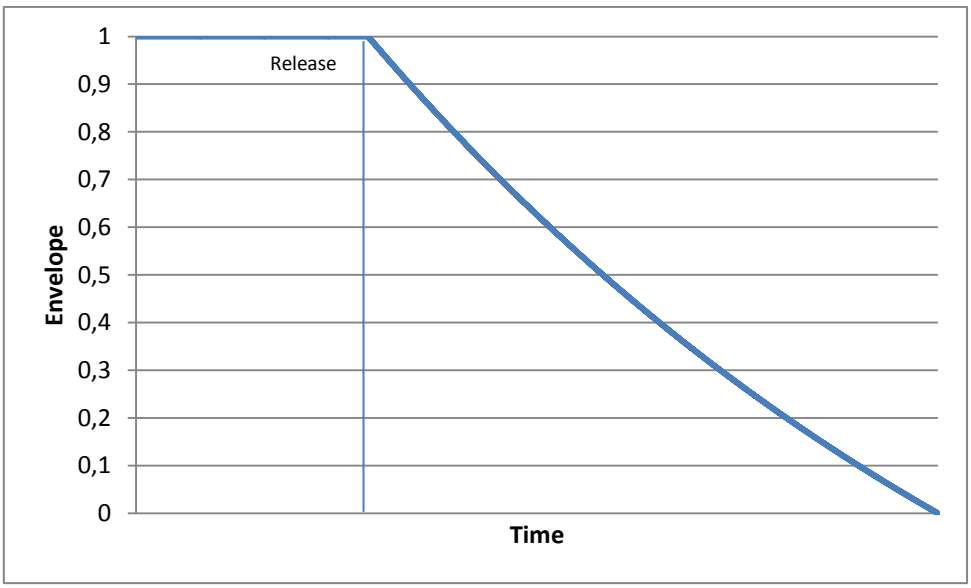
4.3 The Envelope (VCA & MOD ENV 1 & 2) Sections

There are four different envelope generators in Vaporizer: a VCA envelope, a VCF envelope and two modulation envelope generators. All four envelope generators follow a classical ADSR (attack, decay, sustain & release) model. To ensure a realistic high-quality sound they offer different envelope modes.

4.3.1 Envelope Modes

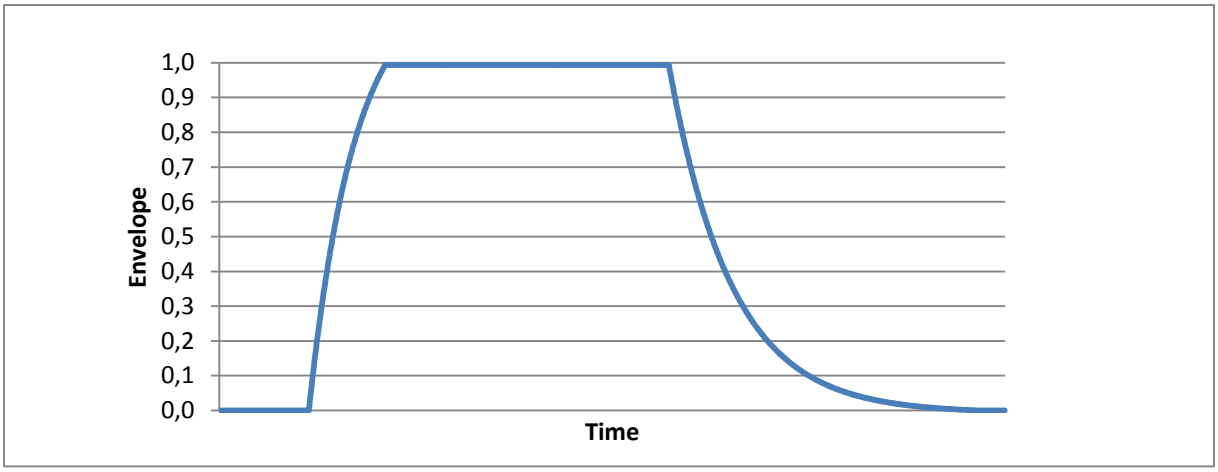
The envelope mode (for VCA and VCF envelopes) controls the way how attack, decay and release curves are generated. The “linear” mode generates an almost linear curve.

The following figure shows a release phase with “linear” envelope mode (sampled real Vaporizer output):



The “analog” envelope mode emulates the behavior of the earliest analog envelope generators which were based around the charging and discharging of an electronic capacitor (capacitive model). The characteristics of an “analog” envelope are that it has a steep attack or decay in the first part of the phase and a more flat curve at the end of the phase.

The following figure shows an example of an “analog” VCA envelope with attack, sustain and release phases (sampled real Vaporizer output):



The “digital” envelope mode emulates the behavior of the first digital envelope generators of the 1980s (e.g. the Yamaha DX7[7]).

4.4 The Filter (VCF) Section

Vaporizer includes a filter bank with three high-quality filter modules plus a comb filter that is technical more part of the effects section. The VCF section supports a very flexible filter routing. The signal path is freely definable. You can change the sequence of the filter banks and arbitrarily define the signal sums (including ring modulation).

All filters are fully stereo and support minimal attack and release times with a response of only a few milliseconds.

All filters support a mix setting (which controls the dry / wet rate of the signal going in and out of the filter), a filter drive (i.e. a pre-gain amplification / attenuation of the signal going in the filter), a cutoff frequency and a resonance level. Note that for some filter effects a certain drive level is helpful to achieve the desired effect.

[7] Yamaha is a registered trademark.

4.4.1 Stereo 2nd Order Resonant Low-pass Filter

Vaporizer includes a stereo 2nd order resonant low-pass filter that is based on the filter design described by Massberg[8] that gives a very clear and analog-style behavior for low frequencies but especially also for the higher frequencies. This filter has a very steep attack and a filter response that allows modeling many unique sounds.

4.4.2 Stereo 2nd Order Resonant High-pass filter

Vaporizer includes a high-quality 2nd order resonant stereo high-pass filter that is based on the filters implemented in the famous Korg[9] MS-10 and MS-20 synthesizers. This filter is a second order resonant filter, yet it has a roll off slope of a first order filter (6dB / octave instead of 12dB / octave) which gives a unique resonance sound. Like the low-pass filters, it can also self-oscillate.

4.4.3 Stereo 8 Pole Resonant Diode Ladder Filter Low-pass Filter

The diode ladder filter is most famous as the resonant filter from the Roland[10] TB-303 bassliner. It is based on the Moog[11] ladder filter but incorporates multiple feedback paths between sections. Like the Moog filter, it reduces overall filter gain as the resonance increases but the reduction is more extreme (by about 12dB). Like the Moog filter it also self-oscillates.

Vaporizer includes two diode ladder low-pass filters for ach voice to upgrade the monophonic behavior to stereo.

4.4.4 Comb Filter

Vaporizer includes a comb filter that technically belongs rather to the effects section as it is not modelled for each voice. Instead it is applied as an effect in the effects chain.

The name “comb filter” is derived from the fact that the frequency response of a comb filter consists of a series of regularly spaced spikes, giving the appearance of a comb. With this the comb filter can generate “flanging” effects as it can filter a signal based on cancellation of “overtone” frequencies.

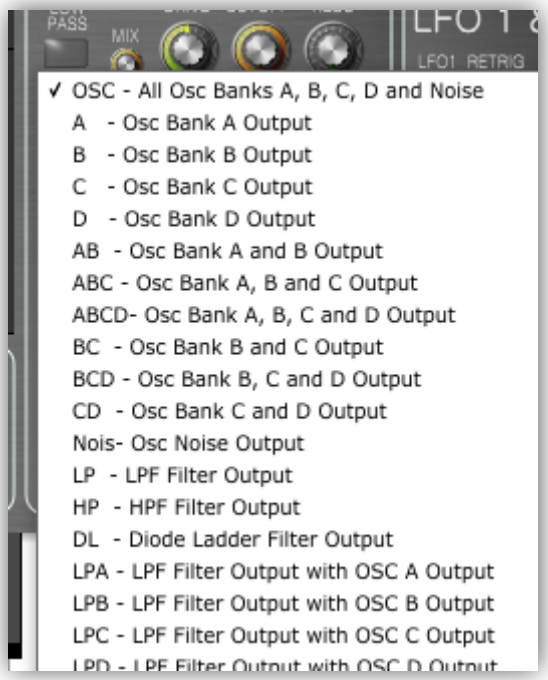
[8] Massberg, M. 2011. Digital low-pass filter design with analog-matched magnitude response. Journal of the Audio Engineering Society (Massberg 2011).
[9] Korg is a registered trademark.
[10] Roland is a registered trademark.
[11] Moog is a registered trademark.

4.4.5 Flexible Filter Routing

An important feature of the filter section is that the signal path from the oscillator banks to the filter modules (and from one filter module to another) can be freely defines in various ways.

To do this you can use the selection box below the filter on / off switch. The structure of the settings here is as follows:

Filter routing	Description
OSC	All oscillator banks A, B, C, D and noise are mixed and used as filter input.
A, B, C, D, Noise	Only the output of the selected bank is used as filter input (note that this is independent of the fact if the bank is used already in another filter as input).
AB, ABC, ABCD, BC, BCD, CD	The outputs of the selected oscillator banks are mixed and used as filter input (note that this is independent of the fact if the banks are used already in another filter as input).
LP, HP, DL	The output of the selected filter is used as input signal for this filter (LP low-pass, HP high-pass, DL diode ladder)!
LP*, HP*, DL*	The output of the selected filter is mixed with the selected oscillator banks and used as input signal for this filter!


PASS
MIX
LFO 1
LFO1 RETRIG
✓ OSC - All Osc Banks A, B, C, D and Noise
A - Osc Bank A Output
B - Osc Bank B Output
C - Osc Bank C Output
D - Osc Bank D Output
AB - Osc Bank A and B Output
ABC - Osc Bank A, B and C Output
ABCD- Osc Bank A, B, C and D Output
BC - Osc Bank B and C Output
BCD - Osc Bank B, C and D Output
CD - Osc Bank C and D Output
Nois- Osc Noise Output
LP - LPF Filter Output
HP - HPF Filter Output
DL - Diode Ladder Filter Output
LPA - LPF Filter Output with OSC A Output
LPB - LPF Filter Output with OSC B Output
LPC - LPF Filter Output with OSC C Output

Here is an example for this flexible routing:

Purpose: High-pass filter a detuned bank and mix the result to a low-pass filter together with the output of another oscillator bank.

Setting: Use bank A with detuned oscillators and bank B with a single oscillator (maybe one octave down as sub-oscillator). Set high-pass filter to mode “A” and low-pass filter to “HPB”. The detuned signal will first go into the HPF alone. The result will be mixed with bank B and together be routed to the LPF.

4.5 The LFO (LFO 1 & 2) Section

Vaporizer comes with two low frequency oscillators (LFOs) that can be used in multiple ways to modulate the signals. Both LFOs can be chosen as input sources in the modulation matrix

(see chapter Modulation Matrix). With this the two LFOs can even modulate each other (e.g. LFO 2 modulates the frequency of LFO 1).

For convenience and ease-of-use reasons LFO 1 offers pre-defined modulation destinations that can be switched on and off without having to “program” the modulation matrix: VCA, VCA stereo-panning (switch on VCA and PAN together), VCF and pitch. The “depth” setting is used to control the modulation amount of these pre-defined modulation destinations only. When using the LFO in the modulation matrix the “depth” has no effect.

The LFOs support seven alias-free LFO waveforms including sample and hold which is very helpful to achieve random effects.

Both LFOs can be synced to the DAW time code or can be free running. When free-running (“SYNC” switched off) the frequency controls the LFO oscillator. When synced to DAW the DAW’s BPM (beats per minute) setting controls the LFO frequency by calculation fractions of whole notes defined by the “STEPS” setting. E.g. quarter notes are defined by a STEPS value of “4”. E.g. triples can be set up with a “STEPS” value of “3”.

Independently of whether the LFO is synced or not, the “RETRIG” setting can be used to control whether the phase of the LFO wave is restarted at the beginning for each new MIDI note or not. Using the retriggering option ensures that each run of the DAW project will produce identical outputs for the modulation.

4.6 The Modulation Matrix

The modulation matrix is the “heart” of the Vaporizer synthesizer plug-in. It allows controlling the sound generation in multiple ways by altering of a huge variety of synth parameters based on internal and external signals and events.

The mechanism behind the modulation matrix is to define an input source (e.g. LFOs, envelopes ...) that modulates a modulation destination with a defined intensity and behavior controlled by the modulation matrix value. With the eight modulation matrix slots, the positive and negative modulation curves and the 11 input sources and the 55 destinations Vaporizer supports more than 10.000 possible different modulation combinations.

The following input sources are available in Vaporizer (note that Vaporizer also includes modulation controlled by external audio sources):

Modulation matrix input source	Description
NoSource (---)	No modulation.
Velocity	The velocity value of the MIDI note played (not only usable for voice gain, can also control filter etc.).
AfterTouch	Polyphonic after touch values send via MIDI for each MIDI note played. Will only affect modulation matrix values of voices of the corresponding MIDI note.
ModWheel	The standard MIDI behavior is that the modulation wheel responds to MIDI CC 1. Vaporizer maps MIDI CC 1 per default to the modulation matrix input source ModWheel (see chapter Modulation Matrix). You can use the modulation matrix to freely assign the modulation wheel to control any of the parameters controllable with the modulation matrix.

ModEnv1	The envelope value of the modulation envelope 1 in the MOD ENV 1 & 2 section.
ModEnv2	The envelope value of the modulation envelope 2 in the MOD ENV 1 & 2 section.
LFO	The output signal of LFO 1. Note that LFO 1 can modulate LFO 2.
LFO2	The output signal of LFO 2. Note that LFO 2 can modulate LFO 1.
KeyTrack	Key track (key follow) of the played MIDI note: higher modulation values for higher MIDI notes (higher frequencies).
InputWave	The unfiltered direct input signal. This is only useful for input signals with very low frequency (e.g. LFO) as other signals will result in audible aliasing.
InputEnvelope	Envelope of the input signal. Vaporizer uses an envelope follower to derive the envelope from the input.

The following destinations are available in Vaporizer. It should be noted that Vaporizer supports **modulation of modulation matrix values** which is a quite unique feature of this software synthesizer:

Modulation matrix destination	Description
No Destination (---)	No modulation.
Pitch	The voice pitch.
Detune	The oscillator banks detune amount (frequency).
Pan	The stereo panning of the output.
Spread	The stereo spread of the differently detuned oscillators within an oscillator bank.
PulseWidth	The length of the pulse waveform shape for all pulse oscillators used in banks A-D.
LFODepth	The modulation depth of LFO 1 (this is only used for the LFO preset buttons – VCA, PAN, VCF & PITCH).
LFOFrequency	The frequency of LFO 1.
LFO2Frequency	The frequency of LFO 2.
VoiceGain	The gain / output volume of the played voice.
OscAGain	The gain / output volume of the oscillator bank A.
OscBGain	The gain / output volume of the oscillator bank B.
OscCGain	The gain / output volume of the oscillator bank C.
OscDGain	The gain / output volume of the oscillator bank D.
NoiseGain	The gain / output volume of the noise oscillator.
OscACents	The fine-tuning of the pitch of the oscillators in bank A. 100 cents correspond to one semitone.

OscBCents	The fine-tuning of the pitch of the oscillators in bank B. 100 cents correspond to one semitone.
OscCCents	The fine-tuning of the pitch of the oscillators in bank C. 100 cents correspond to one semitone.
OscDCents	The fine-tuning of the pitch of the oscillators in bank D. 100 cents correspond to one semitone.
LPFCutoff	The cutoff frequency of the low-pass (LPF) filter.
HPFCutoff	The cutoff frequency of the high-pass (HPF) filter.
DiodeLadderCutoff	The cutoff frequency of the diode ladder low-pass filter.
LPFResonance	The resonance of the low-pass (LPF) filter.
HPFResonance	The resonance of the high-pass (HPF) filter
DiodeLadderResonance	The resonance of the diode ladder low-pass filter.
LPFDrive	The pre-gain amplification / attenuation of the signal going through the LPF filter.
HPFDrive	The pre-gain amplification / attenuation of the signal going through the HPF filter.
DiodeLadderDrive	The pre-gain amplification / attenuation of the signal going through the diode ladder filter.
CombFrequency	The frequency of the comb filter.
CombLevel	The level of the comb filter effect.
CombDrive	The pre-gain amplification / attenuation of the signal going through the comb filter.
LPFMixin	The dry / wet value of the signal going through the LPF filter.
HPFMixin	The dry / wet value of the signal going through the HPF filter.
DiodeLadderMixin	The dry / wet value of the signal going through the diode ladder filter.
CombMixin	The dry / wet value of the signal going through the comb filter.
DistortionDryWet	The dry / wet value of the signal going through the distortion effect.
DistortionDrive	The pre-gain amplification / attenuation of the signal going through the distortion effect.
DistortionFuzz	The fuzz level of the distortion effect.
ChorusDryWet	The dry / wet value of the signal going through the chorus effect.
ChorusFrequency	The center frequency of the left, right, center chorus effect.
ChorusDepth	The depth of the chorus effect.
DelayDryWet	The dry / wet value of the signal going through the delay effect.
DelayTime	The delay time in milliseconds of the delay effect.

DelayFeedback	The feedback percentage of the stereo ping-pong delay effect.
ReverbDryWet	The dry / wet value of the signal going through the reverb effect.
ReverbSize	The reverb size (room vs. plate reverb) of the reverb effect.
ReverbFeedback	The feedback of the combined room / plate reverb effect.
ModMatrixValue1	The modulation matrix value of slot 1. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue2	The modulation matrix value of slot 2. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue3	The modulation matrix value of slot 3. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue4	The modulation matrix value of slot 4. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue5	The modulation matrix value of slot 5. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue6	The modulation matrix value of slot 6. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue7	The modulation matrix value of slot 7. This can be used to modulate modulation matrix entries with the modulation matrix itself.
ModMatrixValue8	The modulation matrix value of slot 8. This can be used to modulate modulation matrix entries with the modulation matrix itself.

Note that Vaporizer supports positive and negative modulation curves. Modulation matrix values follow the following schema:

Modulation matrix value	Behavior
Zero	No modulation
Positive n%	n% of the currently set slider value is modulated, e.g. the modulation matrix will use the parameter value range from (100-n)% value to value.
Negative –n%	n% of the currently set slider value is modulated with a negative curve, e.g. the modulation matrix

	will use the parameter value range from 0 % value to n% value. This modulation will be done with a negative curve. So if e.g. ModEnv1 is used – if the envelope has 1 the filter cutoff will be at the lowest value.

Example for modulation matrix values:

Modulation matrix setting	Behavior
LFO LPFCutoff 100	This means that 100% of the LPFCutoff slider value is modulated – if it is at e.g. 4000 Hz the LFO will modulate from 100 Hz (lowest slider value) to 4000 Hz (current slider value).
LFO LPFCutoff 80	This means that 80% of the LPFCutoff slider value is modulated – if it is at e.g. 4000 Hz the LFO will modulate from 880 Hz (4000-50 * (100-80%)) to 4000 Hz (current slider value).
LFO LPFCutoff 10	This means that 10% of the LPFCutoff slider value is modulated – if it is at e.g. 4000 Hz the LFO will modulate from 3555 Hz (4000-50 * (100-10%)) to 4000 Hz (current slider value).
LFO LPFCutoff -80	This means that 80% of the LPFCutoff slider value is modulated – but from 0 to 80% of its value – if it is at e.g. 4000 Hz the LFO will modulate from 100 Hz (lowest slider value) to 3120 Hz (4000-50 * (80%)) . This modulation will be done with a negative curve. So if e.g. ModEnv1 is used – if the envelope is 1 (at the highest level) the filter cutoff will be at 100 Hz.
For the following destinations that behavior is slightly different: Pitch, LFOFrequency, LFO2Frequency, PulseWidth, OscACents, OscBCents, OscCCents, OscDCents, CombFrequency. For these modulations the "center" is very important and therefore the following rule is used.	
LFO OscACents 80	This means that the LFO will modulate +/-80% around the current OscACents setting – if it is at e.g. 0 cents the LFO will modulate from -960 cents (80% of -1200 cents - lowest slider value) to 960 cents (80 % of 1200 cents) while 0 is kept as center of the modulation .

4.7 The Equalizer (EQ) Section

Vaporizer integrates an 8-band parametric equalizer (EQ) that is helpful for instant tweaks and sound adjustments. The equalizer is modeled with a low-shelf filter at 50 Hz, six peak notch filters at 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz and a high-shelf filter at 16 kHz.

4.7.1 Multi-band Processing

A unique capability of Vaporizer is to split the signal in a center and a left and right chain before it is routed in the delay and reverb modules. This feature is called multiband processing and is useful to ensure that stereo and delay effects of low frequencies do not dilute the sound output.

So Multiband processing allows to route lower frequencies in mono and to bypass effect banks to preserve a high quality low end of the sound.

This feature can be switched on when the EQ section is switched on by choosing a MB CUT frequency other than 0. This frequency is the split frequency that divides center (mono) and stereo signals (higher than MB CUT).

4.8 The Effects (FX) Section

One of its philosophies of Vaporizer is to produce wet sounds that are immediately usable in music productions. Therefore it includes a complete effect bank in the layout.

All effects can be switched on / off individually and can be mixed in and out by using a dry / wet parameter.

4.8.1 Distortion

The distortion effect implements a fuzz wave shaper with a definable pre-gain amplification / attenuation and fuzz factor.

The fuzz distortion model, of course, introduces per design a complete non-linear behavior. Therefore it can be oversampled if the resulting aliasing is not desired.

To achieve the best possible audio result the module implements a pre- (low-shelf at 800 Hz) and post EQ (high-shelf at 2000 Hz) filter for the wet signal.

4.8.2 Chorus

The chorus effect module in Vaporizer emulates a classical and powerful left-center-right chorus as it is used in vintage Korg[12] synthesizers. As the module is fully stereo enabled it uses six independent triangle low-frequency oscillators, each with its own depth and frequency.

For convenience the user-interface only offers one central parameter for chorus frequency and depth. The six LFO parameters are calculated out of this in the module automatically.

[12] Korg is a registered trademark.

The chorus supports oversampling as doing so generates a really unique and fat sound.

4.8.3 Delay

The delay module is a ping-pong stereo delay with feedback and an adjustable delay time.

Note that you can bypass low-frequencies from being routed through this module by using multi-band processing.

4.8.4 Reverb

Vaporizer comes with a combined room / plate reverb with internally included four times filter oversampling. The reverb feedback can be freely defined.

The reverb size controls the dry / wet mix between the room reverb module and the plate reverb module. E.g. “SIZE” = “0” will purely use the room reverb module. “SIZE” = “100” will purely use the plate reverb module. While “SIZE” = “50” will equally mix the outputs of both room reverb and the plate reverb modules.

Note that you can bypass low-frequencies from being routed through this module by using multi-band processing.

4.9 The Arpeggiator (ARP) Section

Vaporizer has a “brutally analog sounding” arpeggiator module that is based on a transpose, gate, velocity and hold model. It comes with more than twelve arpeggiator and sequencer patterns and four different arpeggiator modes (polyphonic, up, down, up / down).

The arpeggiator can be synced to the DAW time code or can be free running. When free-running ("SYNC" switched off) the speed is derived from the "BPM" setting and the "STEPS". When synced to DAW the DAW's beats per minute setting controls the speed by calculation fractions of whole notes defined by the "STEPS" setting. E.g. quarter notes are defined by a "STEPS" value of "4". E.g. triples can be set up with a "STEPS" value of "3".

The internal engine is already prepared for user defined arpeggiator and sequencer patterns. At the time being there is no editor in Vaporizer available for these custom patterns. It is planned to introduce this in one of the next upcoming versions of the software.

4.10 The Keyboard Section

Vaporizer offers a virtual keyboard that can be used to trigger MIDI notes. By using the arrow keys on both sides the visible and playable key range can be adjusted.

5. MIDI Mapping

Many parameters in Vaporizer can be remote controlled via MIDI. The default MIDI controller to parameter mapping follows general MIDI conventions and the MIDI standard.

But there are more controllable parameters in Vaporizer as free MIDI CCs (control change messages). Therefore the MIDI Learn function (see MIDI Learn chapter) allows to freely define a custom specific mapping of CCs. This mapping will be persisted and is not preset specific. So it will be available again and again after restarting Vaporizer.

The following table gives an overview over the default MIDI controller to parameter mapping in Vaporizer:

Midi CC	Parameter Name	Internal Parameter ID (used in XML)
Master Section		
1	(mapped to modulation matrix source ModWheel; can be assigned to parameter in addition)	

5	Portamento	m_iPortamento
111	Master Volume	m_fMasterVolumedB
Oscillators Section		
53	Detune	m_fOscDetune
54	Spread	m_fSpread
106	Osc A Gain	m_fOscAGain
107	Osc B Gain	m_fOscBGain
108	Osc C Gain	m_fOscCGain
109	Osc D Gain	m_fOscDGain
110	Noise Gain	m_fNoiseGain
VCA Envelope		
73	Attack Time	m_fAttackTime
36	Decay Time	m_fDecayTime
37	Sustain Level	m_fSustainLevel
72	Release Time	m_fReleaseTime
Filters Section		
38	Filter Attack	m_fAttackTimeVCF
39	Filter Decay	m_fDecayTimeVCF
40	Filter Sustain	m_fSustainLevelVCF
41	Filter Release	m_fReleaseTimeVCF
74	Cutoff LPF	m_fFilterCutoffLPF
42	ResonanceLPF	m_fFilterResoLPF
43	Cutoff HPF	m_fFilterCutoffHPF
44	Resonance HPF	m_fFilterResoHPF
45	Cutoff Diode Ladder	m_fFilterCutoffVADL
46	Resonance Diode Ladder	m_fFilterResoVADL
LFO Section		
78	LFO Frequency	m_fLFOFreq
79	LFO Depth	m_fLFODepth
80	LFO2 Frequency	m_fLFO2Freq
Effects Section		
81	Distortion	m_iDistortionOnOff
82	Distortion DryWet	m_fDistDryWet
83	Dist Fuzz	m_fDistFuzz
84	Dist Drive	m_fDistDrive
85	Chorus	m_uChorusOnOff
86	Chorus DryWet	m_fChorusDryWet
87	Chrous Depth	m_fChorusDepth
88	Chorus Rate	m_fChorusRate_hz
89	Delay	m_iDelayOnOff
90	Delay Wet	m_fDelayWet
91	Delay Time	m_fDelayTime

92	Delay Feedback	m_fFeedback_Pct
93	Reverb	m_iReverbOnOff
94	Reverb Wet	m_fWet_pct
95	Reverb Damping	m_fReverbDamping
96	Reverb Feedback	m_fRT60
Modulation Matrix		
112	Modmatrix Val 1	m_fModMatVal1
113	Modmatrix Val 2	m_fModMatVal2
114	Modmatrix Val 3	m_fModMatVal3
115	Modmatrix Val 4	m_fModMatVal4
116	Modmatrix Val 5	m_fModMatVal5
117	Modmatrix Val 6	m_fModMatVal6
118	Modmatrix Val 7	m_fModMatVal7
119	Modmatrix Val 8	m_fModMatVal8

6. Trouble Shooting

6.1 Optimizing Performance

Vaporizer is optimized for performance and low CPU usage. The complete critical path is SSE vectorised and supports parallel processing. Yet as Vaporizer's high-quality synthesis model relies on ad-hoc calculation and processing some settings might cause a higher CPU load.

The following settings can lead to intensive CPU requirements:

Oversampling

Please note that a four-times oversampling is a CPU intensive process. By using highly-optimized assembler SSE routines Vaporizer guarantees that the CPU consumption is not four-times as high compared to a non-oversampled signal. Yet oversampling will have an impact on the CPU consumption for sure. Usually oversampling in Vaporizer is not technically required as the synthesizer's oscillator and filter sections are completely alias free. Yet some effects like distortion are non-linear by design and can produce higher-quality sounds when oversampled.

You can try to use the EQ to boost higher frequencies instead of using oversampling. In some scenarios this might lead to a similar result with less CPU consumption.

Modulation matrix

The modulation is effectively buffered and optimized. Yet patches with intensive usage of the modulation matrix will have a higher CPU consumption. You can try to reduce the number of used modulation matrix slots in such a case.

Number of voices / oscillators

Using a high degree of polyphony will require more voices and thus will lead to more intensive CPU processing. You can reduce the polyphony mode from POLY16 mode to POLY4 or MONO mode in that case.

Also avoiding the usage of a higher number of oscillators as necessary should be avoided. Please try to reduce the number of parallel used oscillators in each bank if necessary.

Switching off what is not needed

You should switch off all sections, filters and effects that are not used in the processing of your patch.

6.2 Other Problems

Patches are not saved when saving the project in the DAW

Saving patch data to the DAW is not supported in the demo version of Vaporizer. Please consider purchasing a license.

Parameter values change unexpectedly

Please check your MIDI and MIDI Learn setting by using the context menu of the parameter control knob / slider.

Low-quality sound output

Make sure that you use appropriate sound interface and buffer settings in your DAW (see chapter System Requirements).

7. Legal Information

7.1 Copyright

Vaporizer is © 2015 by VAST Dynamics GbR, Lindenweg 59, 69126 Heidelberg, Germany.

7.2 Special Thanks

Special thanks to:

- My family for understanding that DSP programming sometimes requires some time.
- Tom “Truepiano” Trupiano for contributing great presets, great demo songs and adding many valuable ideas and concepts to Vaporizer.
- The folks at the KVR Audio forums that contributed with feedback and ideas to what Vaporizer is today.

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